

Dairy Industry Facilities Manual (Draft 8/03)

**Prepared by Dr. Sandra Amass, Director, National Biosecurity Resource Center
On Behalf of the FMD Dairy Working Group.**

Table of Contents-

Table of Contents-	2
Preface	5
Chapter 1: Introduction	5
Chapter 2: Responsibilities of Animal Emergency Response Organizations and Related Personnel	6
National Animal Health Emergency Management System (NAHEMS)	6
Federal Operational Responsibilities	7
State Operational Responsibilities	8
Chapter 3: Minimizing Disease Risk in Routine Practice	8
Foot-and-mouth disease	8
Vaccination	9
Procedural awareness	11
Traceback and Traceforward Recommendations	11
Record Keeping	12
Traceforward Procedures for dairy animals and products	13
Quarantine Procedures on Dairy Farms	14
Entry procedures	15
People	15
Vehicles	16
Feed	16
Exit Procedures	16
People	16
Vehicles	17
Feed	17
Personal Protection and Safety	17
Movement Controls	17
Euthanasia	18
Gunshot	18
Captive Bolt	19
Pithing	19
Exsanguination	19
Injectable Euthanasia Agents	19
Carcass Disposal	19
Burial	19
Landfills	20
Composting	20
Tissue Digestion	21
Incineration	21
Rendering	22
Milk and Wastewater Disposal Options	22
Manure and Feed Disposal	23
Biologics, Drugs and Supply Disposal Options	24
Vector Control Options	24
Cleaning and Disinfection Options	25
Cleaning	25
Disinfection	26
Replacement Options	27
Artificial Insemination, Germplasm Collection, and Embryo Transfer Protocols	28
Semen	29
Germplasm and Embryo Transfer	29
Chapter 4: Minimizing Disease Risk Within an Infected or Suspect Zone	29
Testing	29

Vaccination.....	30
Entry and Exit procedures	30
Entry Procedures.....	30
Exit Procedures.....	31
Personal Protection and Safety	31
Within Premises Movement Controls.....	31
Euthanasia and carcass disposal	32
Milk, Manure, Feed, Biologics, Drugs and Supply Disposal Options.....	32
Milk Shipment.....	32
Cattle/Animal Shipment	32
Vector Control Options.....	32
Cleaning and Disinfection Options.....	32
Replacement, Artificial Insemination, Germplasm Collection, and Embryo Transfer Options.....	32
Chapter 5: Minimizing Disease Risk Within a Surveillance Zone	32
Vaccination.....	33
Entry Procedures.....	33
Exit Procedures.....	33
Personal Protection and Safety	33
Within Premises Movement Procedures.....	33
Milk Shipment Procedures	33
Cattle Shipment	33
Manure, Feed, Biologics, Drugs and Supply Disposal, Vector Control, and Artificial Insemination, Germplasm Collection, and Embryo Transfer Procedures.....	33
Chapter 6: Minimizing Disease Risk On Non-Infected Premises within Suspect, Infected, or Surveillance Zones	33
Vaccination.....	34
Quarantine Policy	34
Entry procedures.....	34
People	34
Vehicles	34
Feed	35
Exit Procedures.....	35
People	35
Vehicles	35
Feed	35
Within Premises Movement Controls.....	35
Euthanasia, Carcass Disposal, Milk Disposal, Manure and Feed Disposal, Biologics, Drugs and Supply Disposal, Vector Control, and Cleaning and Disinfection Options	35
Replacement Options.....	35
Artificial Insemination, Germplasm Collection, and Embryo Transfer Protocol	36
Chapter 7: Milk Movement	36
FMD Outbreak Milk Control Zone.....	37
FMD Milk Area Control Zone.....	38
FMD Milk Buffer Control Zone	38
Chapter 8: Milk Tanker and Vehicle Biosecurity for Milk and Supply Movement.....	38
Drivers	39
Chapter 9: Milk Plant Biosecurity	40
Milk Tanker Receiving	40
Driver/Dairy Plant Personnel Biosecurity	41
Sample Collection.....	41
Weigh In	41
Unloading Milk.....	41
Contaminated Milk	41
Clean Milk	41
Milk Tanker Washing and Cleaning.....	42
Milk Tanker Release.....	43
Milk Tanker Released and then Found to Be Contaminated	43

Milk Processing	43
Raw Storage.....	43
Pasteurization.....	43
Milk	44
Butter	45
Cream	45
Cheese.....	45
Casein	46
Product Isolation and Testing	46
Dairy Plant Waste	46
Product Distribution	47
Chapter 10: Current Producer Recovery and Compensation Policy	47
Chapter 11: Veterinary Responsibilities	47
References: References will be numbered for the final draft.....	47
Acronyms	52
Glossary	52
Appendices	52

Preface

In the event of an outbreak of foot-and-mouth disease (FMD) in the U.S., this Dairy Industry Facilities Manual will serve as a guideline for all partners in the National Animal Health Emergency Management System (NAHEMS), including USDA, States, the Veterinary Profession and the livestock industry. It is developed to be integrated into and consistent with the U.S. Emergency Response Plan System (USREPS) developed for USDA/APHIS/Veterinary Services. It is designed as a guideline for all NAHEMS partners and other interested parties to utilize in any animal health emergency involving the dairy industry in the U.S.

This Dairy Industry Facilities Manual contains as much information, as practicable, relative to the contents of the USREPS Operational Manuals. As appropriate, the text is referenced to specific paragraphs within the USREPS Operational Manuals and other USREPS documents where additional and more specific information is available.

These biosecurity recommendations are based on current knowledge and experiences with FMDV to date. These recommendations will likely change as new research information becomes available. Moreover, there is always the risk of a new or altered form of FMDV that could circumvent these recommendations. Consequently, even if all recommendations are followed, there is still the risk of FMDV spread. These recommendations are intended to minimize this risk based on our current knowledge.

Of course, the key to controlling an outbreak is to prevent FMD from entering the farm in the first place. Producers have the responsibility of ensuring biosecurity procedures are in place on their farms. A survey of 18 dairies found that fewer than half tested incoming cattle for specific diseases and only about half quarantined incoming cattle. Moreover, quarantine facilities were many times directly adjacent to the main herd or even in the same barn as the main herd (Faust MA, Kinsel ML, and Kirkpatrick MA, 2001). These are high risk practices as the easiest way to introduce FMD to a herd is by bringing in an infected animal. A good relationship between the veterinary practitioner and the dairyman including regular herd health and biosecurity checks could help with the early detection of FMDV and be one of the best prevention policies. The need to get practitioners back on farms was cited as a lesson learned from the U.K. 2001 outbreak (British Veterinary Association Council, 2001).

Chapter 1: Introduction

The U.S. Dairy Industry, both producers and processors, will be adversely impacted by any outbreak of a highly contagious animal disease in the U.S. such as FMD. Therefore, it is imperative that the industry develops the necessary contingency planning to both prevent and mitigate, to the extent possible, all potential adverse impacts of any such disease incursion.

This Dairy Facilities Manual offers guidance to all interested and involved stakeholders who may find it necessary to determine policy, procedures and appropriate control methods to address such an outbreak when and if the dairy industry becomes affected. From this Dairy Facilities Manual, a separate but consistent Dairy Emergency Preparedness and Response Plan will be

developed that specifically addresses the responsibility of all stakeholders who comprise and represent the U.S. dairy industry.

These guidelines are meant for use as a practical field resource. This Manual is organized to address policy based on current information and science when possible, and designates need for future additional supporting research or information when scientific basis is unavailable. It is also arranged in a chronological order to address the most important control and response elements, leading from a general knowledge base to specific elements necessary to effectuate control on and around an infected premises to carcass disposal and final clean-up and restocking.

These guidelines focus on essential areas such as traceback, quarantine procedures, vehicle movement, people movement, animal movement, feed movement, personal protection, euthanasia, carcass disposal, milk disposal, manure disposal, waste disposal, vector control, cleaning and disinfection, restocking options, and milk plant biosecurity. This document is designed for use not only in emergency situations but also in animal health emergency training programs.

Chapter 2: Responsibilities of Animal Emergency Response Organizations and Related Personnel

National Animal Health Emergency Management System (NAHEMS)

NAHEMS is a product of the National Animal Health Emergency Management Steering Committee which is composed of four major stakeholder groups, including the livestock industry, State and Federal animal health officials and the veterinary profession. It provides an overall national coordinated system for planning, preventing, responding and recovery from any major animal health related incursion, including natural disasters, emerging animal health issues, and foreign animal diseases. Under NAHEMS a preparedness and response infrastructure is being developed and implemented through the Incident Command System (ICS) under FEMA at the national level and under SEMA at the State level.

Under NAHEMS, the State Animal Health Emergency Management System (SAHEMS) is utilized as a first line of defense for diagnosing, sampling and reporting a suspicious animal health related problem. SAHEMS, as necessary, calls for support and assistance from the USDA Regional Emergency Animal Disease Eradication Organization (READO), rather than relying on READO as a first line of defense which has been the traditional mode of operation.

NAHEMS also invokes the concept of Regionalization, meaning that a highly contagious animal disease outbreak must be quickly diagnosed, confirmed and isolated from other areas or regions of the Nation. Therefore, policy decisions relating to establishing quarantines, movement control zones and vaccination must be coordinated with the need to isolate and regionalize the animal disease outbreak, thus minimizing the risk of spread and maximizing the continued ability of the U.S. to export milk and meat products.

Federal Operational Responsibilities

The Federal response capability is coordinated with the State Incident Commander (SIC). In most situations this will be the State Veterinarian. The Foreign Animal Disease Diagnostician (FADD), who conducts the initial investigation of a suspect Foreign Animal Disease (FAD) or unknown emerging animal disease situation, consults with the State Veterinarian, Area Veterinarian in Charge (AVIC) and the Chief Animal Health Veterinarian of the U.S. This consultation produces recommendations regarding sampling, initial premises quarantine decisions, initial movement restrictions and other policy decisions necessary to prevent further spread of the potential disease agent. In addition, decisions are made relative to the need for declarations of emergency at the State and Federal levels. This consultation also determines the need for backup support and activation of the READO teams.

Once samples are received at the Foreign Animal Disease Diagnostic Laboratory (FADDL) on Plum Island, it is the federal responsibility to provide a presumptive diagnosis in less than 24 hours.

Before leaving an FMD-confirmed site or FMD investigation site, the FADD will work with the producer or owner to institute appropriate biosecurity and public health measures, if warranted, and will thoroughly clean and disinfect their clothing, equipment and vehicle. Until a presumptive diagnosis is made, the FADD will not go on any other premises of unknown or negative status. If the presumptive diagnosis is positive, the FADD should not go on another premises of unknown or negative status for at least 48 hours.

USDA is also responsible for administering compensation for foreign animal disease emergencies, including foot-and-mouth disease as described in (9CFR Part 53). Current USDA compensation policy covers property required to be destroyed as a result of a disease eradication effort. Property destroyed can include animals, animal products such as milk, other agricultural products and byproducts, feed, bedding, equipment, other materials and facilities. Generally, USDA provides compensation at fair market value that reflects intended use of the property. Fair market value is currently determined by on-site appraisals of the property. USDA/APHIS is exploring other ways to expedite the appraisal process.

USDA has provided compensation for susceptible animals infected with or exposed to the disease. Consideration is also being given to compensation for nonsusceptible animals ordered to be cleaned and/or disinfected or destroyed. Any cleaning and disinfection costs directly incurred by owners or operators will be reimbursed by USDA.

In States unable or unwilling to assume Joint Incident Command responsibilities to control and/or eradicate a highly contagious animal disease outbreak, USDA/APHIS will assume such responsibility through deployment of READO by declaring an Extraordinary Emergency. If an emergency situation dictates the need for a national moratorium on all animal movement, this becomes the responsibility of the Animal Plant Health Inspection Service (APHIS) of USDA to administer under an Extraordinary Emergency Declaration.

State Operational Responsibilities

State responsibility is centered on the need to develop rapid and immediate response capability to investigate reports coming from producers, practitioners, State Animal Diagnostic Labs, State personnel in the field and federal Veterinary Medical Officers (VMO's). State personnel should coordinate with the AVIC, State Veterinarian and other involved animal health officials to determine the source of the potential outbreak and make arrangements for the FADD to conduct the initial on-site investigation. Depending on the nature and potential severity of the situation, the State Veterinarian then advises other State authorities regarding the need to institute a State Declaration of Emergency and/or activate the State Emergency Response Plan. In addition, the State Veterinarian determines the need to request additional federal resources in consultation with USDA animal health officials, as described above.

Based on the outcome of the presumptive testing and consultation described above, a State quarantine may be placed on the FMD-confirmed or FMD investigation site; depopulation and disposal undertaken; appropriate movement control zones established around the quarantined premises(s); local agricultural and emergency officials notified; and all contacts to the farm will be traced. Trace-backs are usually applied for a minimum of 2 times the maximum incubation period before the onset of clinical signs. Trace-forward is usually applied up to the time quarantine is imposed.

A confirmed positive case finding requires the State Veterinarian to continue quarantine, movement restrictions and active case investigations. If State controls are deemed inadequate, the State Emergency Management Director of SEMA will evaluate the need to request a Presidential Declaration of Emergency, which if provided, implements the Federal Response Plan.

Chapter 3: Minimizing Disease Risk in Routine Practice

Routine practices are extremely important in maintaining animal health. Topics covered in this chapter are recognition of foot-and-mouth disease; procedural awareness, traceback and traceforward recommendations; record keeping; tracing procedures for animals, products, and people; quarantine policy; entry and exit procedures for people, vehicles, and feed; personal protection and safety; movement controls; euthanasia; carcass disposal, milk disposal; manure and feed disposal; replacement options; and introduction of genetic material.

Foot-and-mouth disease

Foot and mouth disease is a highly contagious viral disease of cloven-hoofed animals. The disease usually has a sudden onset and is characterized by fever and vesicular lesions. Foot and mouth disease was first described by an Italian Monk in 1514. The disease is currently endemic in most of the major livestock producing countries in the world with the exception of the United States, Canada, New Zealand, Australia, and Japan. The last FMD outbreak in the United States was in 1929.

FMD virus (FMDV) is a single stranded RNA Aphthovirus in the Picornovirus family. There are seven immunologically distinct types of FMDV (Types O, A, C, Southern African Territories (SAT)-1, SAT-2, SAT-3, Asia 1) with at least 61 subtypes.

The following is a list of FMD-free countries as of 12-30-02 (O.I.E.): Albania, Australia, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Chile, Costa Rica, Croatia, Cuba, Cyprus, Czech Rep., Denmark, El Salvador, Estonia, Finland, Former Yug. Rep. of Macedonia, France, Germany, Guatemala, Guyana, Greece, Honduras, Hungary, Iceland, Indonesia, Ireland, New Zealand, Netherlands, Norway, Panama, Poland, Portugal, Italy, Korea (Rep. of)*, Japan, Latvia, Lithuania, Luxembourg, Malta, Mauritius, Mexico, New Caledonia, Romania, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, United States of America, and Vanuatu. An updated list can be found at: http://www.oie.int/eng/info/en_fmd.htm.

Foot-and-Mouth Disease is primarily transmitted by contact with infected animals however there is evidence that FMDV can be spread via aerosol, ingestion of infected animal products, or by mechanical vectors such as birds, insects, rodents, wildlife, equipment, clothing, etc. The virus is usually inactivated by alkaline (>12) or acid pH (< 4.5).

The incubation period for the virus ranges from hours to days, but commonly signs are observed between 2 and 6 days after exposure. Classic signs include excess salivation and lameness due to painful vesicles on the mouth and feet. Vesicles can also be observed on the teats. Producers can observe fever, poor appetite, decreased milk production, weight loss, abortion, and inactivity before vesicles are observed.

Vaccination

In the United States, we have the luxury of effective vaccines for most diseases. However, routine vaccination against foot-and-mouth disease in the United States is not permitted because of the impact on our nation's status for international trade. The North American Vaccine Bank contains limited doses of FMD vaccine in case of an outbreak situation for use in all species of susceptible animals. The distribution of the vaccine must be jointly agreed upon and used by the United States, Canada, and Mexico. Currently, the vaccine is in a central location and would have to be transported to affected regions.

Protection conferred by the vaccines is variable and the vaccines only can provide protection from homologous types of FMDV. The stored vaccines are bacterins. Generally, 7 to 10 days are needed after vaccination for the animal to build an immune response. Thus, vaccination will not help animals that are already infected. Moreover, laboratory studies have found that vaccinated and unvaccinated animals became infected with FMDV after oral or nasal exposure. Circulating antibodies from vaccination did not prevent the establishment of carrier animals. (Sutmoller P, McVicar JW, Cottral GE., 1968; McVicar JW and Sautmoller P, 1969). Therefore, vaccination does not prevent infection. Vaccination only masks the clinical signs of infection. Thus, vaccinated animals could become infected and shed virus to infect other animals, but appear healthy. In a few cases where live FMD vaccines were used, outbreaks due to vaccination ensued. Finally, although in development, there is no commercial test available in the United States to discriminate between vaccinated and unvaccinated, infected animals.

Vaccination has been used in outbreaks to date. In the 2000 Republic of Korea FMD outbreak all susceptible livestock in affected provinces were vaccinated with the intent to eventually slaughter all vaccinated animals (Joo Y, An S, Kim O, Lubroth J, Sur J, 2002).

Modeling studies have had mixed outcomes dependent on the model assumptions. Studies using data from early in the 2001 UK outbreak concluded that minimizing animal movement, culling of animals on infected farms within 24 hours and culling animals on contiguous farms (FMD-FMD-investigation site) within 48 hours was the most effective control strategy. The epizootic increased with delays in culling infected and contiguous animals. Vaccination of cattle alone resulted in failure to contain the outbreak. Vaccination of cattle in a buffer zone in conjunction with implementing culling policies resulted in a slightly smaller epidemic but was costly and impacted future trade. The model did not account for vaccination of other susceptible species such as sheep so the conclusions are likely not accurate (Morris RS, Wilesmith JW, Stern MW, Sanson RL, Stevenson MA, 2001). Another model concluded that vaccination within a 50 Km radius of a FMD-confirmed site decreased the size and length of an epizootic (Bates TW, Thurmond MC, Carpenter TE, 2003). However, the inputs to the model were not described in the paper, including critical information such as vaccination strategy (ie. species vaccinated, effectiveness of vaccine, etc). Therefore, the accuracy of the model cannot be evaluated.

An analysis of the first 2 months of the UK 2001 FMD epidemic predicted that culling would be more effective than vaccination and that ring culling or buffer vaccination would be more effective than simply culling infected animals (Ferguson NM, Donnelly CA, Anderson RM, 2001).

A recent study regarding the cost-effectiveness of vaccination during an outbreak concluded that vaccination might be cost-effective if vaccinated animals were not subsequently slaughtered and there were no economic impacts such as trade restrictions due to vaccination status. Moreover, the investigators report that conditions needed for vaccination to be cost-effective (highly efficacious vaccines, vaccination of herds within 7 days of the start of the outbreak (7 days includes, production, delivery, and administration of vaccine to all designated herds), available test to discriminate vaccinated from unvaccinated animals, etc) might be overly optimistic. Adverse effects as a result of vaccination could prove costly to the industry. Any expenses saved by vaccinating animals would likely be negated if vaccinated animals had to be subsequently slaughtered (Bates TW, Carpenter TE, Thurmond MC, 2003). Currently, commercial vaccines will not prevent infection; therefore, even if one could test to distinguish between vaccinated and unvaccinated animals, the vaccinated animals will have to be eventually slaughtered, causing vaccination to not be cost-effective.

Future research and technological developments could produce a cross-protective foot-and-mouth disease vaccine that prevented vaccinated animals from becoming infected with FMD. **If** this vaccine was readily available, easily administered, and antigenically different from wild strains of FMDV, vaccination would be a feasible alternative to pre-emptive slaughter. In this theoretical case, the dairy industry would recommend ring vaccination immediately following designation of the milk control zones (See Chapter 7). Vaccination of all susceptible animals in the FMD Outbreak Milk Control Zone would be undertaken to minimize the potential spread of FMDV and the number of animals to be euthanized and disposed. The exact procedures for vaccination would be dependent on the outbreak strain (Some types of FMD do not infect

bovines). The species with the greatest likelihood of amplifying and spreading the virus would be vaccinated initially, followed by lesser risk species. Vaccine handling will be dependent on the type of vaccine developed with some vaccines needing refrigeration to maintain efficacy and others that are stable at room temperature. The most efficient means of vaccination would be to begin with large herds which have the most at-risk animals. Animals could be vaccinated by the veterinarians and first response teams as samples are collected and tested to determine the herds FMD status. These diagnostic teams will already be in place and following strict biosecurity procedures.

Currently, in the event of an outbreak, vaccination recommendations must be determined by the USDA in consideration with OIE rules. The exact policies and procedures for use of stored vaccine are currently in discussion.

Procedural awareness

Members of the dairy industry should be prepared for an outbreak situation before one happens. Everyone should be aware of the initial chaos that will immediately ensue. Good preparation will convert the chaotic atmosphere into a controlled situation.

Immediately upon detection of a FMD positive animal, state and national authorities will establish movement restrictions and testing zones. Initially, a widespread restriction in product and animal movement will be established. As animals are tested and results become known, officials will be able to ascertain the location and extent of the outbreak. Once ascertained, zones will be established on a national basis. Dairy farms will be assigned both an outbreak control zone and a milk movement control zone.

Traceback and Traceforward Recommendations

Information must be collected from producers when FMD or other diseases are suspected. Information regarding the origin of all animals, animal products, feedstuffs (hay, straw, grain, supplements), equipment, vehicles (milk tankers, livestock trucks, feed trucks, veterinary trucks) people (sales and feed representatives, visitors, veterinarians, technicians, A.I. service personnel) that have visited the farm prior to the outbreak is used in “traceback” procedures to identify the source of the virus and determine how FMD got to the farm. Procedures can be implemented to minimize future risk of disease introduction once the source of the virus has been identified. Similar information regarding animal and equipment movements off the farm are used in “traceforward” procedures to determine other premises that possibly received infected animals, animal products, or contaminated equipment. This information is essential to contain the spread of FMD as rapidly as possible (USDA policy; Primary Industries Ministerial Council of Australia and New Zealand. 2002).

We recommend routinely maintaining herd records and updated back-up copies of records on a regular basis to assist in both trace-forward and traceback procedures when needed. Attempting to acquire information during an outbreak situation is difficult due to the chaotic nature of a disease outbreak. Regular herd records allow the producer to rapidly and accurately produce movement records greatly facilitating the tracking procedures. Moreover, individual animal identification will enhance the efficiency of tracking procedures. A single individual on each

premises should be responsible for maintaining accurate records although every employee should know how to access the records in case of an emergency.

Record Keeping

The following are recommendations for records to be kept by Dairy producers on a regular basis:

- Inventory of animals in the herd (ID, Breed, Age, Species, Origin). Animals that die or are culled from the herd should be identified. A necropsy and appropriate testing to determine cause of death should be done on all animals that die on the farm and a report should be located in the records. We recommend implementing the cattle passport system using the Passport system in Great Britain as the model. The passport system allows traceability of cattle throughout their lifetime. Each calf is assigned a permanent ID and a passport. The passport details how to identify the animal and all movements of that animal. Records of all animal movements should be moved with the animal when ownership changes. The passport stays with the animal allowing anyone to trace the movement of the animal throughout its lifetime.
- Animal movement to and from the farm logs (Date, Animal ID, origin, destination, reason, driver, vehicle used, Previous Owners name and phone number)
- Milk (Product) movement logs (Date, Batch ID, origin, destination, driver, vehicle used)
- Visitor logs (names, phone numbers, reason for visit, time since last contact with livestock, facilities entered). Visitors include all non-employees (veterinarians, feed salesman, inseminators, livestock dealers, repairmen, neighbors, etc)
- Vehicles/Tankers (Driver, dates, origins, destinations). Encourage drivers to record stops made during pick-ups before unloading at the dairy plant or transfer station.
- Equipment, feed, semen, embryo movement logs (dates, origins, destinations, delivery person, salesman, inseminator's name)
- Manure application/movement logs (dates, origin, application site, volume, and application method)
- Vaccination and Treatment records (Animal ID, Date, Reason for treatment/vaccination, medication (product used))
- Employee records (Name, Address, Phone number, Does employee have contact with other livestock?)
- Pets and other animals located on the premises
- Cull animals/Steers sold (number, date, location)

Additional information will be requested in the event of an outbreak because effective tracing of animals, animal products, equipment and vehicles is key to determining the source of the outbreak. Immediately after a presumptive or confirmed diagnosis of FMD, investigators require information regarding all movements of animals (livestock and pets), products (milk, meat), manure, equipment, vehicles, people, and feed to the farm premises for the 21 days preceding the outbreak. Information designated above will be used. The Field Unit Veterinary Supervisor will designate one person to coordinate tracing information and movements. Producers are encouraged to have the following information readily available for personnel investigating the outbreak:

- Owner(s) of animals: name, telephone number, mailing address, email address
- Owner(s) of premises (if different from animal owner): name, telephone number, mailing address, email address
- Location of FMD-confirmed site or FMD-investigation site (State, county, township)
- Written directions to the premises including distance and miles from nearest city or town
- Person who reported the disease (producer, veterinarians, etc) and date of reporting
- Date that clinical signs or lesions were observed by the owner (ie, fever, vesicles, decreased production, abortions, etc.)
- Traceback Procedures for dairy animals and products

Traceforward Procedures for dairy animals and products

Effective tracing of animals, animal products, etc. that moved off of the premises before the premises was quarantined is key to rapid containment of the outbreak. Immediately after a presumptive or confirmed diagnosis of FMD, investigators require information regarding all movements of animals (livestock and pets), products (milk, meat), manure, equipment, vehicles, people, and feed off of the farm premises for the 21 days preceding the outbreak to the present. All interstate movements and intrastate movements within and outside of the quarantine area (surveillance zone- changes meaning) should be recorded. The Field Unit Veterinary Supervisor will designate one person to coordinate tracing information and movements. Each State is encouraged to have meetings with FSIS, APHIS and the State Department of Agriculture to develop a reporting process and a brief action plan for traceforward procedures.

Veterinary inspectors, other inspectors, and dairy plant managers of dairy plants receiving animals or products from quarantined and suspect areas(FMD-confirmed site or FMD-investigation site) should be immediately contacted. Additionally, vehicle movement records should be used to notify all drivers, transfer stations, and premises where vehicles containing potentially infected product stopped so that these premises can be assessed and decontaminated as needed. Product from the quarantined area should be traced forward and the risk of spread of FMD assessed. Movements of product from the dairy plants should be halted until that dairy

plant could be tested for presence of FMDV. A dairy plant that has received raw milk implicated to have FMD should stop production to do clean in place (CIP) and clean out of place (COP) procedures if these procedures have not already been done.

Steers grown on the premises or cull cows are a potential source of infection for livestock if their meat was shipped to an FMDV-free area, blood products from the animals were fed to swine, or bones were given to farm dogs that then carried them to livestock areas.

Infectious FMDV virus survived on meat packing materials held at 4°C and approximately 85% relative humidity for extended times. Infectious FMDV was recovered at 35 to 398 days from blood, serum, lymph node and fat contaminated cardboard; 48 to 57 days from blood and lymph node contaminated metal, and 33 to 187 days from blood, serum, lymph node and fat contaminated wood. Presumably FMDV could be recovered for longer duration when contaminated meat packing materials are held at standard temperatures of -1 to 1°C thereby risking transfer of the virus with meat shipments (Gailiunas P, Cottral GE, Scott FW, 1969). Processing plants should be notified if they received infected livestock.

Notification and tracing movements of people associated with livestock (veterinarians, feed dealers, salesman, inseminators, etc) that have been in the quarantined area should occur at the time of a presumptive or confirmed case of FMD. A written report of all activities of these people should be collected for the 21 days preceding the outbreak including dates of farm visits, vehicles and equipment used. Decontamination procedures for clothing, equipment, vehicles, and medications/vaccines brought to the premises should be implemented. Contaminated items that are disposable should be discarded by burial or incineration after decontamination. Personnel should shower and don clean clothing and footwear before contacting livestock or livestock premises. Each premises with susceptible livestock that the personnel visited within the quarantine area should be inspected daily for at least 3 weeks for signs of FMD. Premises and livestock visited outside of the quarantined area should be quarantined and placed under daily inspection.

Quarantine Procedures on Dairy Farms

Quarantines are used to control movement of livestock and products when an exotic disease such as FMD is suspected. State and federal regulatory authorities can impose quarantines. Federal quarantines stop interstate movement and state quarantines stop intrastate movement. The Secretary of Agriculture must declare an Extraordinary Emergency to give Federal authority to control livestock movements within the state.

In cases of highly contagious diseases such as FMD, the virus could spread a considerable distance before Federal regulatory agencies could impose a state quarantine. Thus, we recommend that the State Veterinarian consider a stop movement order on all livestock and products from strongly suspect or infected premises (FMD-confirmed site or FMD-investigation site) until the epidemiology of the outbreak is understood. Stopping movement of livestock and contaminated products was the single most important method to contain the outbreak cited among lessons learned from countries experiencing FMD outbreaks in 2001. Rapid quarantine is

crucial to containment of an outbreak. We further recommend that producers self-impose quarantines if suspicious lesions are observed in their herd or neighboring herds.

Entry procedures

People

Non-essential visitors to dairy farms are frequent. A survey of 156 dairies reported 234 to 743 individuals and/or vehicles visited their dairy farm each month. This rate increased by one indirect contact per month as dairy farm size increased by 4.3 animals. Dairy calf and heifer units with greater than or equal to 250 animals reported 609 visits by people and/or vehicles each month (Bates TW, Thurmond MC, Carpenter TE, 2001). Each visitor to a dairy farm poses a minimal risk of infection; however, it just takes one contaminated person or object to cause or spread a disease outbreak.

Previous studies using FMDV strains O₁ Swiss, A₅, O₂, and C Noville reported that human nasal carriage of FMDV occurred in one of eight people at 28 hours but not at 48 hours after exposure to infected animals (Sellers and others 1970). Showering did not prevent human transmission of O₁ BFS 1860 or C Noville FMDV to one of four steers when people exhaled, coughed, and sneezed directly onto the muzzle of the steers for 2.5 minutes (Sellers and others 1971). This close contact is not common on dairy farms; however during an outbreak, contaminated people could be in close contact with susceptible animals.

However, two recent studies show the need for biosecurity procedures during an outbreak situation. First, investigators contacted and sampled FMDV (O/UK/35/2001)-Inoculated pigs for approximately 45 minutes and then contacted and sampled sentinel pigs and sheep after using no biosecurity procedures, washing hands and donning clean outerwear, or showering and donning clean outerwear. FMDV was detected in nasal secretions of one investigator immediately after necropsies of FMDV-Inoculated pigs but was not detected in human samples collected from 12.75 to 84.5 hours after exposure. After contaminated personnel showered and changed into clean outerwear they did not transmit the U.K. outbreak strain of foot-and-mouth disease virus to susceptible pigs and sheep (Amass SF, Pacheco J, Mason P, et al., 2003).

In a second study, investigators contacted and sampled FMDV (O/Taw/97)-Inoculated pigs for approximately 40 minutes and then contacted and sampled sentinel pigs after using no biosecurity procedures, washing hands and donning clean outerwear, or showering and donning clean outerwear. Personnel were sampled for nasal carriage of FMDV for 85.43 hours. Contaminated personnel did not transmit FMDV to susceptible pigs after hand washing or showering, and donning clean outerwear. FMDV was transmitted when biosecurity procedures were not used. FMDV was not detected in nasal secretions of investigators. Thus, extended animal avoidance periods do not appear to be necessary to prevent transmission of FMDV by people to pigs when organic material is removed through hand washing/showering and donning clean outerwear (Mason P, Amass SF, et al, unpublished data, 2002).

People are rarely infected by FMDV; therefore, mechanical transmission of FMDV by people wearing contaminated outerwear offers the greatest risk of spread.

To minimize risk of human spread of FMDV, visitors should not be allowed on (FMD-confirmed sites or FMD-investigation sites) except for essential personnel. People should not handle infected stock and then go to another farm without implementing proper biosecurity procedures (British Veterinary Association Council, 2001). Thus, we recommend that all personnel who knowingly enter an outbreak, suspected outbreak, or farm at high risk of being infected, shower and don clean outerwear before proceeding to an uninfected dairy farm.

Vehicles

A survey of 156 dairy farms reported: (1) The mean number of dairies visited by a tanker before going to the dairy plant was 1.8 farms with a range of 1 to 5 farms; The mean number of dairies visited each day by a tanker was 9.4 farms with a range of 2 to 17 farms; and tankers traveled approximately 209.2 miles in a single day (Bates TW, Thurmond MC, Carpenter TE, 2001). Thus, vehicles can be a mechanical vector of FMDV if they travel from and infected (FMD-confirmed site or FMD-investigation site) farm to a susceptible farm. Manure, mud, etc can be tracked via tires or simply fall from the exterior of an unwashed vehicle.

We recommend implementing procedures to reduce the risk of vehicles transporting disease. Some suggestions include limiting farm entry to one gated road. The gate should be locked when not in use. A buzzer on the gate can notify farm personnel of visitors. The farm perimeter can be secured by fence line. Keep parking areas away from livestock. Keep vehicle logs to record date, origins, destinations, drivers, and reason for visit for all vehicles.

Milk tankers should not enter FMD-confirmed sites or FMD investigation sites.

Vehicles should be cleaned and disinfected after visiting each farm and before arriving at the next farm. Tire sprayers can be used as an adjunct to washing to remove soil from tires as the vehicle approaches the farm. Tire sprayers will not replace whole vehicle washing as they only clean the tires. Despite being cleaned, vehicles should not enter premises of FMD-confirmed sites or FMD investigation sites. A parking area should be designated at the farm entrance and essential personnel can walk to the livestock areas.

Feed

Feed can be brought to uninfected dairies within the quarantine (surveillance) zone. Preferably the feed should originate from other uninfected dairies within the quarantine (surveillance) zone or uncontaminated suppliers within the quarantine (Surveillance) zone.

Exit Procedures

People

People contacting infected livestock, FMD-confirmed sites or FMD investigation sites must be decontaminated before leaving the premises. A shower area should be set up with a separate entrances and exits so that a dirty side and a clean side can be established. People should remove

all contaminated clothing and boots for destruction on the dirty side. People should then take a complete shower and wash thoroughly until all visible organic material is removed from their hair, body, and underneath their fingernails. People should exit the shower on the clean side and then dress in laundered, uncontaminated clothing and footwear. After donning clean outerwear, people must immediately exit the facility. Under no circumstances should people exit through the dirty side. If such recontamination occurs, the people must repeat the process and then exit on the clean side. After exiting the farm, a second shower at home/hotel/or base is suggested before entering a clean farm. A person may go to another contaminated farm after one shower.

Vehicles

All vehicles entering the premises should be considered contaminated. Contaminated vehicles should not exit the farm premises. If vehicles must exit, visible organic material should be removed from the vehicle and the vehicle should be thoroughly cleaned and disinfected prior to leaving the premises and before entering another premises.

Feed

Crops and grains from fields that were sprayed or injected with effluent from a FMD-confirmed site within 21 days of diagnosis should be destroyed by burial or plowing under. Hay and Straw should be decontaminated and destroyed and should not be used as feed or bedding for livestock (AUSVETPLAN, 2002).

Personal Protection and Safety

Foot and mouth disease is not considered a public health problem; however, personnel should be prepared for an outbreak at any time. Personnel should don waterproof disposable outwear and footwear so that they can be decontaminated with ease. Personnel should not transport any FMDV-contaminated fomites, animals, or animal products to FMDV-free areas containing susceptible animals.

Only personnel with experience in using firearms should be present and participate in mass culls where shooting is the method of euthanasia.

The emotional toll of farm depopulation is the greatest human health concern. Crisis hotlines should be available for farmers, their families, and emergency personnel working at the scene. Suicide might be a consideration for farm owners. Removal of all personal firearms by family members to a secure site is advised if farmers appear at risk. Emergency personnel should be cautious when approaching the farm as they could be threatened physically. In the event of a person(s) refusal to cooperate or a physical threat, state animal health officials should retreat from the premises and immediately report the incident to the incident command so it can be mitigated by law enforcement. Military or police support might be required to carry out testing and culling policy.

Movement Controls

Good production practices recommend that personnel should always move from areas in the farm of the highest health status to areas of lower health status to avoid tracking disease to healthy animals. During outbreaks, movement among contaminated areas of the farm will be unrestricted initially. However, as depopulation and decontamination progress, personnel moving within contaminated premises should take care to minimize tracking the virus to uncontaminated areas within the farm. Areas that have been cleaned and disinfected should be marked off and avoided so that they are not recontaminated.

Euthanasia

A plan for euthanasia and carcass containment should be in place for both routine farm management and in the case of an outbreak requiring depopulation. Carcass containment plans should be in place **before** euthanasia begins.

Euthanasia of infected animals is crucial because persistently infected cattle can carry FMDV in their soft palate and pharynx despite having “protective” antibody levels to FMDV and having no clinical signs of disease (Zhang ZD and Kitching RP, 2001).

Euthanasia of any swine on the premises should be foremost as swine amplify and spread the virus. All cattle and other susceptible animals (including pet sheep and goats) must be euthanatized on infected farms(FMD-confirmed sites).

Humane euthanasia methods include gunshot or captive bolt followed by pithing as needed or injection of euthanasia solution. Animals should be relocated to the carcass containment area before euthanasia, if possible, to decrease labor needed to drag dead carcasses out of buildings. Frequently machinery cannot easily access carcasses left in stalls.

Gunshot

Shooting livestock can be dangerous and should not be performed close to populated areas. Shooting has the advantage that livestock do not need to be individually handled and can be shot at a distance. Only essential personnel with firearm experience should be in the area during euthanasia and personnel should communicate frequently to avoid injury. Hollow, soft point ammunition is recommended for paddock shooting. A steel jacket bullet of no less than 30 caliber is recommended (North Carolina State Animal Response Team 2002-2003). In Australia, recommended ammunition is 0.22 to 0.44 magnum. Shooting should occur at the shortest range possible without placing the firearm in direct contact with the animal’s head (AUSVETPLAN, 1996).

The gun should be pointed towards the spine at the intersection of lines drawn from the base of the horns (or where the horns used to be) to the opposite eye for adult cattle. Aim about 1 cm to the side of this point for bulls. Shoot small calves just behind the poll on the mid-line aiming at the muzzle. Alternatively the animal can be shot from the side so that the bullet enters the skull horizontally halfway between the eye and the base of the ear. (AUSVETPLAN, 1996).

Captive Bolt

The captive bolt gun can be dangerous to the operator and must be properly maintained to ensure effectiveness. Animals must be restrained and the captive bolt gun placed in contact with the animal's head in the proper position. Cattle over one year old will need to be pithed after stunning with the captive bolt gun (AUSVETPLAN, 1996).

The captive bolt should be placed in contact with the animal's head at the intersection of lines drawn from the base of the horns (or where the horns used to be) to the opposite eye for adult cattle. Aim about 1 cm to the side of this point for bulls. Place the captive bolt on small calves just behind the poll on the mid-line aiming towards the muzzle (AUSVETPLAN, 1996).

Pithing

Pithing facilitates death of the animal by destroying brain tissue. A rod is inserted through a hole made by a firearm or captive bolt gun and then retracted (AUSVETPLAN, 1996).

Exsanguination

Exsanguination is not recommended because blood contains FMDV which can then contaminate people and facilities. Also, bloody floors are slippery and pose a danger to personnel (AUSVETPLAN, 1996).

Injectable Euthanasia Agents

A licensed veterinarian can only administer injectable euthanasia agents. Injection of euthanasia solution by a veterinarian is a practical method for small numbers of calves or on hobby farms.

Carcass Disposal (Livestock disposal)

Carcass (livestock) disposal methods should be tailored to the infectious disease. For example, carcass disposal methods are important as FMDV has been reported to survive in lymph nodes, blood clots, and muscle of for up to 60 days (4°C; pH 6.0-7.1) and in bone marrow for 73 days (4°C; pH 7.5) from carcasses of infected animals (Cottral GE, Cox BF, Baldwin DE, 1960). FMDV was detected in bone marrow from infected cattle for 210 days and hides for 352 days after storage at 1 to 7°C (Cottral GE, 1969).

Carcass disposal must be performed in accordance with state regulations and environmental constraints. Dogs, cats, and other predators should not be allowed access to carcasses.

Producers can be proactive and contract for machinery and equipment needed to dispose of carcasses in the event of an outbreak.

Burial

Producers are encouraged to check state statutes, have their land approved for burial, and designate the land needed to accommodate burial of the farm's livestock population well in

advance of an outbreak. Burial is appropriate in areas with a deep water table and non-porous soil. Reinforcement of pit walls is needed in areas with sandy soil. Generally pits should not be deeper than 8 feet and should be covered to avoid scavenging. (Sander JE, Warbington MC, and Myers LM 2002) Trenches should be 7 feet wide and 9 feet deep and the carcasses should be covered with at least 6 inches of soil (Bagley CV, 2002). Burial can be difficult, especially during the winter months (Byers FM, 2001). Burial sites (Livestock disposal sites) should be filled and capped as quickly as possible to avoid leaching and odors especially during warm weather (Scudamore JM, Trevelyan GM, Tas MV, Varley EM, Hickman GAW, 2002). Lime should not be added to pits since the lime slows down the natural decomposition of carcasses (Scudamore JM, Trevelyan GM, Tas MV, Varley EM, Hickman GAW, 2002).

Landfills

Some landfills will accept animal carcasses. (Sander JE, Warbington MC, and Myers LM 2002) Landfills are costly and prompt carcass disposal is difficult. Transportation of carcasses to the landfill carries the risk of further disease spread (Bagley CV, 2002).

Composting

Composting can be defined as the controlled decomposition of organic materials. Decomposition occurs when organic materials go through a "slow cooking" process as microorganisms metabolize the organics. Rapid decomposition is an aerobic process, requiring oxygen. The process will produce carbon dioxide, water vapor, heat, and compost. The combination of the cooking process, rapid degradation, and compost cover minimizes odor and flies (Byers FM, 2001).

Composting is an environmentally friendly method of carcass disposal. Cattle carcasses take about 9 to 10 months to compost. The process is hastened if the carcass can be cut into smaller pieces. Scavenging of carcasses must be prevented. (Sander JE, Warbington MC, and Myers LM 2002)

Carbon Source requirements: Large animals such as cows and horses should be composted in sawdust, moist but not wet silage, screenings from a manure flush system or other carbon material with discrete small particles. A base layer of dry material should be placed at least one foot deep under the animal to act as a sponge for fluids that seep from the carcass. The bigger the animal the deeper the base layer. The base layer should extend at least two feet beyond all sides of the animal. The animal should be covered with compost ingredient material to form a peaked pile such that a minimum of one foot of cover exists all around the animal. Multiple large animals can form a windrow. As to the exact quantity per animal it depends on the size but for mature cows it might range from 4 to 6 cubic yards of material per animal (Byers FM, 2001).

Carbon Medium: Sawdust is the best medium to mix with mortalities. Other high carbon materials including chopped straw, corn cobs, corn silage, mixture of manure and straw/sawdust, etc. may be possible but sawdust in research trials at the Ridgetown College of Agricultural Technology gave highest temperatures and fastest breakdown of materials. For every kilogram of mortality to be composted one kilogram of sawdust is needed (A 20 liter pail of sawdust weighs approximately five kilograms.). If the mixture gets too dark during the compost period, more

sawdust should be added. The mortalities can be buried into the medium as they occur. (Byers FM, 2001).

Animal Preparation: Usually large animals are cut to expose internal organs to the sawdust or other compost materials you use. Large muscle masses can be sliced to increase surface area. Leg tendons need to be sliced so that the animal can be laid backbone down and legs folded. However, some farmers make no preparation and simply bury the animal in compost material with no less success at carcass degradation (Byers FM, 2001).

Site Preparation: The composting site begins with a twelve-inch layer of sawdust. This layer will insulate the composting material from the outside environment, provide carbon to fuel the composting process, and provide sufficient space between particles to allow gas flow and preserve the aerobic nature of the pile. Alternative carbon sources such as poultry litter or bedding material can be substituted for sawdust with similar results. Ensuring adequate moisture content within the compost pile is necessary for optimal activity, and using a carbon source already possessing significant water content will reduce the requirement for additional water. Carcasses are then evenly placed on this carbon layer, taking care to keep them at least six inches from the side walls. These carcasses are then covered with another twelve inches of sawdust, and water is added to this layer to keep the pile uniformly moist. Liquid manure can be substituted for water. As more mortalities become available, additional layers are added to the pile in the same manner. If a large animal is added to the pile, it may be necessary to dig a trough in the existing pile into which the animal can be inserted and then covered (Byers FM, 2001).

Composting options include (1) Static Piles-Static piles take a long time to compost; (2) Open Windrows -Open windrows are labor intensive. A windrow 12 feet wide by 6 feet high will hold approximately 300 pounds of mortality per foot of length. The materials required per foot of windrow length (300 pounds of mortality) would be 14 cubic feet of litter (400 pounds) and 16 cubic feet of wood chips, sawdust, or straw (700 pounds); (3) In-Vessel Composting-construction costs are often prohibitive for this type; and (4) AG-Bag Environmental's EcoPOD Technology (<http://www.ag-bag.com/>). The Ag bag system requires grading for a hard packed surface, water for adding moisture before filling pod, and electricity for powering the aeration system (Byers FM, 2001).

Tissue Digestion

Tissue digestion: Alkaline hydrolysis of tissues is another option. Strong bases at high temperatures and pressures are used to dissolve tissues. The by-product can be released into a sewage system. Teeth and bone mineral residue will be present (Sander JE, Warbington MC, and Myers LM 2002).

Incineration

Incineration is expensive and has public opinion drawbacks. EPA regulates incineration (Sander JE, Warbington MC, and Myers LM 2002). Fuel sources and throughput must be considered (Byers FM, 2001). Napalm has been suggested as a rapid, heat intensive, economical method of burning carcasses. Time for incineration is 60 minutes (Martin Hugh-Jones, 2001). Two studies regarding burning of carcasses on open pyres concluded that FMDV was not transmitted in

smoke from the pyres (Champion HJ, Gloster J, Mason IS, Brown RJ, Donaldson AI, Ryall DB, and Garland AJM, 2002; Gloster J, Hewson H, Mackay D, Garland T, Donaldson A, Mason I, Brown R, 2001). In Great Britain, public health officials recommended that open pyres containing 1000 or more carcasses be built at least 3 Km from public areas. Personnel were advised to avoid prolonged exposure to smoke from the pyres (Scudamore JM, Trevelyan GM, Tas MV, Varley EM, Hickman GAW, 2002).

Air curtain incinerators can be used as stand alone models or portable units to be set up over trenches (Bagley CV, 2002). More information on air curtain incinerators can be found at <http://www.airburners.com>. Air curtain incinerators can burn 2 to 6 cattle per hour; however, dry seasoned timber was found to be the only effective fuel (Scudamore JM, Trevelyan GM, Tas MV, Varley EM, Hickman GAW, 2002).

Rendering

Rendering will likely not be feasible in the case of a large outbreak due to transportation restrictions and volume requirements. Moreover, hides from rendered animals pose a risk of FMDV transmission. FMDV was reported to remain infectious in green salted hides stored at 15°C for 90 days and for 352 days when stored at 4°C. Infectious FMDV was recovered from hides cured by salting in a saturated sodium chloride solution (500 ppm available chlorine) after 4 weeks of storage at 15°C. Infectious FMDV was recovered from hides after drying for 6 weeks at 20°C and 40% relative humidity. Infectious FMDV was recovered after 21 days from hides that had been salt cured for 1 week and dried at 20°C (Gailunas P and Cottral GE, 1967). The renderer's truck can act as an agent to spread disease and should not be allowed to enter infected premises (FMD-confirmed site or FMD-investigation site).

Milk and Wastewater Disposal Options

Farms should have procedures in place for disposal of small and large amounts of milk and wastewater. Your veterinarian or extension agent can help you formulate waste management protocols tailored to your facilities. The herd size, milking equipment, disinfectants/cleansers used, milk holding tank size, and on-farm treatment options are a few considerations to account for in your plan (Haskell RR, 2003). Local, state and federal environmental statutes should be consulted before formulating a disposal plan.

Milk contaminated by infectious disease agents might require a separate disposal plan. For example, decontamination and disposal of FMDV-infected milk is important to prevent further spread of infectious FMDV via milk or milk products. The likelihood is good that milk will be shipped from infected cows before cows show clinical signs of FMD or before FMD is diagnosed at the farm of origin. Once FMDV is detected in the United States all dairy plants should immediately prohibit the use of waste milk or milk products for animal feeds. Thus, protocols are needed to track virus in milk that has reached processing plants, milk loaded into tankers, and milk at transfer stations. Milk contaminated with FMDV does not pose a human health concern; however, uncooked milk or dairy products should not be fed to susceptible animals or exported to FMDV-free areas due to the risk of spreading the disease. In the event that FMDV contaminated milk has been traced to a processing plant, trace outs of waste milk or

waste milk products should be undertaken to ensure that the waste was not fed to susceptible animals. Any premises where susceptible animals that were exposed to FMDV contaminated milk should be quarantined and investigated immediately.

The following protocols can be used to decontaminate milk prior to disposal. Target pH should be less than 4.5 or greater than 12. Acidifying bulk tanks might not work because the fat might protect the virus.

- Milk should be mixed with acid or hypochlorite and allowed to sit for one hour (AUSVETPLAN, 1996).
- 2% solution of citric acid: Mix 200 grams of citric acid in 10 liters of milk (AUSVETPLAN, 1996). Milk can be acidified with 2% citric acid then disposed (de Klerk PF, 2002).
- Acetic acid: Add 200 milliliters acetic acid to 10 liters of milk (AUSVETPLAN, 1996).
- 2-3% calcium hypochlorite (pool chlorine): Add one kilogram of calcium hypochlorite to 30 liters of milk (AUSVETPLAN, 1996). 500-1000 ppm chlorine can also be used (AUSVETPLAN, 1996).
- Sodium hydroxide can be used to alkalize milk by slowly adding 600 milliliters of concentrated solution (50 per cent w/w, S.G. = 1.53) to 100 liters milk until pH above 11 is reached (AUSVETPLAN, 1996).

Decontaminated milk can be disposed of as per normal farm protocol. Some suggestions for disposal of decontaminated milk follow:

- Milk can be disposed of in a solid waste landfill (AUSVETPLAN, 1996) or lagoon.
- Small quantities of decontaminated milk on the farm can be disposed of in the burial pit or the effluent pit (AUSVETPLAN, 1996).
- Large quantities of contaminated milk should be decontaminated and pumped into a shallow fenced-off pit and covered after the milk has evaporated or been absorbed into the soil. Milk can also be sprayed or injected onto land (AUSVETPLAN, 1996).
- Pasture should not be grazed for 3 months in hot climates and for at least 6 months in cold climates as FMDV virus has been reported to survive in soil and manure for this duration (Bartley LM, Donnelly CA, Anderson RM, 2002).

Manure and Feed Disposal

Every farm should have a manure management plan in place. Manure disposal options will change if an infectious agent is involved. The following are examples of manure disposal options in the case of FMD:

Waste incoming to the lagoon should be alkalinized ($\text{pH} > 11$) or acidified ($\text{pH} < 4.5$). After treatment, aeration can be continued in aerobic lagoons. Incoming waste to anaerobic lagoons should be acidified. Contaminated lagoons can be acidified or alkalinized for a set period of time and then neutralized (AUSVETPLAN, 1996).

Manure should not be removed from farms if at all possible. Manure should be acidified with 2% citric acid until a $\text{pH} < 4.5$ is met. Slurry can be acidified to $\text{pH} < 4.5$ by mixing thoroughly with 38% nitric acid. Acidified manure and slurry can be mixed with other waste and incinerated (de Klerk PF, 2002). Manure and slurry were recommended to be left on the farm for 80 days before restocking to allow FMDV to degrade (de Klerk PF, 2002); however, the time for degradation will vary with climate and 3 to 6 or more months might be necessary.

A plan for disposal of contaminated feed should also be a part of the general farm management plan. In the case of FMD, feed was subjected to the same protocols as manure in the 2001 Netherlands outbreak (de Klerk PF, 2002).

Biologics, Drugs and Supply Disposal Options

Farms should have procedures for disposal of biologics, drugs, and supplies. Routine incineration is recommended.

Vector Control Options

Farm management plans should include procedures for the control of disease vectors. Wildlife and feral animals (dogs, cats, pigs) can act as vectors of diseases such as foot-and-mouth disease. Susceptible wildlife can act as biological vectors, in which case, the animals would become infected with FMDV and then shed the virus in secretions and excretions to susceptible livestock by direct or indirect contact. Non-susceptible species can act as mechanical vectors by tracking foot-and-mouth disease-laden excretions (manure) to areas containing susceptible livestock, which can then become exposed to FMDV.

Biological vectors of FMDV include deer and feral swine. White-tailed deer became infected with FMDV type O, subtype 1, strain CANEFA-2 after intranasal inoculation and contact exposure to FMDV. Deer to deer, deer to cattle, and cattle to deer transmission of FMDV has been demonstrated. One deer carried the virus for 11 weeks after infection (McVicar JW, Suttmoller P, Ferris DH, Campbell CH., 1974). However, in a recent survey, only 2 out of 149 dairy farm owners reported seeing deer, elk or feral swine near their cattle (Bates TW, Thurmond MC, Carpenter TE, 2001). Perimeter fencing can be used to control some wildlife; however, fencing is often not practical. Deer observed on the premises of infected herds (FMD-confirmed sites or FMD-investigation sites) should be shot.

Mice can become infected with FMDV after experimental inoculation (Campbell CH, 1960); however, natural infection of FMDV by mice has not been reported. Most likely rodents act as mechanical vectors of FMDV by tracking excreta or carrying contaminated feedstuffs. Measures to prevent rodents from entering facilities include optimization of sanitation and rodent-proof construction. Feed should be stored in rodent-proof buildings and feed spills should be cleaned up as soon as possible. Poor sanitation will attract rodents to the area. A 3-foot weed-free, rock perimeter around buildings discourages nesting. Controlling rodents can be accomplished through strategic baiting and trapping. Fumigation can be used to control burrowing rats. A professional exterminator is sometimes required to facilitate an effective rodent control program. Cats are not recommended for rodent control because the cats can act as mechanical vectors for FMDV. (Timm RM, Marsh RE, Corrigan RM, Holscher K, 1987).

Dogs and cats can also act as mechanical vectors of diseases such as FMDV. Dogs should not roam freely among the farm. In the case of an outbreak, kenneling or otherwise enclosing dogs in FMDV-contaminated areas is recommended. Dogs should be thoroughly washed and dried before removal from premises into clean areas. (MAFF, 2001). Cats should not be kept on farms. Feral dogs and cats should be trapped and humanely euthanatized.

Exotic pets such as pot-bellied pigs and hedgehogs can become infected with and act as reservoirs of FMDV (Simpson, 2002). Potbellied pigs or pet hedgehogs should not be kept on premises containing susceptible livestock or as pets of animal caretakers.

Cleaning and Disinfection Options

Proper sanitation is key to preventing and controlling disease outbreaks. All farms should have procedures in place for routine farm sanitation as well as for outbreak situations. The following are guidelines to help prepare farm protocols

Cleaning

Field efficacy of a disinfectant is dependent on a variety of factors including but not limited to: cleanability and other properties of the surface, water quality (hardness, pH, inorganic ions), and organic material (feed, excreta, secreta). Cleanability varies among surfaces. Wood is traditionally difficult to clean, but laminated plastics, PVC plastic, and galvanized steel can also be difficult to power wash because the water jet cannot work as effectively on a smooth surface as it can on a rough surface (Sundahl AM, 1975).

Hard water, which is water containing dissolved calcium, magnesium, manganese, or iron, can affect disinfectants. Curds form when soaps/ disinfectants are added to hard water making it difficult for the soap to remove the dirt (Oregon State University Extension Service, 1984). Organic material interferes with efficacy by either inactivating the disinfectant or blocking the disinfectant from surface contact.

Use of detergents did not enhance bacterial kill as compared to power washing with water alone. (Kihlstrom SL et al, 2001). Moreover, detergent did not decrease cleaning time or improve cleanability. There is evidence that dirt is more efficiently dissolved when detergents are used.

The resulting solution can then be more easily absorbed into the surface making the dirt more difficult to clean away (Sundahl, 1975).

Pre soaking the room/equipment with water before cleaning might be more efficient at improving cleanability.

Disinfection

Disinfectant selection will vary with the disease agents on the farm. For example, phenols and cresols were not very effective in inactivating FMDV in lymph (Fellowes ON,1960). Regardless, all visible organic material must be removed from inanimate objects before disinfection or the disinfectant will not work. Options for disinfectants in the case of FMD are below. Virkon® S and Oxy-Sept® 333 are the only commercially available disinfectants with label approval in the United States for FMDV but field efficacy against FMDV has not been tested in independent studies. Chemicals can also be purchased in bulk and used to inactivate FMDV. Suppliers identify these chemicals by their generic name and synonyms, which are listed below. Trade names are not used for many chemicals.

- Virkon® S is mixed by adding 1.3 ounces (37 grams) of Virkon S powder to 1 gallon of water and mixing thoroughly (USDA, APHIS, 2001). The solution should be allowed to contact the surface for at least 10 minutes after application.
- Oxy-Sept® 333 is prepared by adding 4 ounces of Oxy-Sept® 333 to 8 gallons of water and mixing thoroughly. The solution should be allowed to contact the surface for at least 10 minutes after application.
- 1-2% sodium hydroxide inactivated FMDV in 1 minute. 2 % sodium hydroxide was needed in the presence of cattle urine, manure or soil (Fellowes ON,1960). A 2% solution is prepared by adding 1/3 cup of NaOH pellets (2.7 ounces of the lye) to 1 gallon of cold water and mixing thoroughly. A 5 log reduction in FMDV takes less than 15 seconds at pH 12.5 (Sellers, 1968). Synonyms for sodium hydroxide include: caustic soda; sodium hydrate; soda lye; lye; and white caustic. Beckart Environmental, Inc is one supplier of sodium hydroxide in 25% and 50% concentrations.
- 4% to 5% sodium carbonate (soda ash) inactivated FMDV in 15 minutes at 60°C, but sodium carbonate was not as effective as sodium hydroxide (Fellowes ON,1960). Sodium carbonate is prepared by adding 5.33 ounces of sodium carbonate to 1 gallon of hot water (or 1 pound to 3 gallons of hot water and mixing thoroughly. The solution is mildly caustic. A 5 log reduction in virus titer occurs after 30 minutes of exposure at pH 11 (Sellers, 1968). Sodium carbonate or soda ash is widely available in many quantities through agricultural and chemical distributors.
- 1% sodium hypochlorite inactivated FMDV in 1 minute (Fellowes ON,1960). A 3% solution of 5.25% sodium hypochlorite (NaOCl) can be prepared by adding 3 gallons of

chlorine bleach to 2 gallons of water and mixing thoroughly. Organic matter will reduce activity (Sellers, 1968; USDA, APHIS, 2001). Clorox bleach and many generic industrial forms of sodium hypochlorite are available.

- Hydrochloric acid at 1:250 inactivated FMDV (Fellowes ON,1960). A 5 log reduction in FMDV takes less than 15 seconds at pH 2.2 (Sellers, 1968). Pharmco products, Inc is one supplier of bulk hydrochloric acid.
- Phosphoric acid provided a 5 log reduction in FMDV in less than 15 seconds at pH 2.5 (Sellers, 1968).
- Potassium permanganate and chlorine did not work well in the presence of organic matter (Fellowes ON,1960). Potassium permanganate is a controlled substance.
- 5% citric acid inactivated FMDV in 2 minutes or aerosolization of 3.5 gm citric acid per cubic meter inactivated FMDV in 6 hours (Fellowes ON,1960). A 5 log reduction in FMDV took less than 15 seconds at pH 4 (Sellers, 1968). There are multiple commercial suppliers of bulk citric acid.
- 4-5% acetic acid is prepared by adding 6.5 ounces of glacial acetic acid to 1 gallon of water and mixing thoroughly (Sellers, 1968; USDA, APHIS, 2001). Astro Chemicals, Inc is one supplier of glacial acetic acid in bulk.
- Sodium metasilicate provided a 5 log reduction in FMDV in less than 15 seconds at pH 12 (Sellers, 1968). Chemical Products Corporation is one supplier of sodium metasilicate in bulk.

Replacement Options

A plan should be in place for repopulation of the farm in the event that a farm must be depopulated due to disease. Timing of replacement and repopulation will depend on the disease agent. Information regarding FMD follows.

Infectious FMDV has been recovered from cattle stalls 2 weeks after removal of cattle (Pirtle EC and Beran GW, 1991). FMDV has been reported to survive in the winter for up to 21 weeks in soil, 24 weeks in manure, 15 weeks in sewage, 11 weeks in brick, adobe, or wood barns, 29 weeks in a haystack, and 14 weeks on cotton clothing, leather shoes and rubber boots (Cottral GE, 1969). FMDV has been reported to survive in the summer for up to 1 week in soil, 1 week in manure, 3 weeks in sewage, 2 weeks in brick, adobe, or wood barns, 4 weeks in a haystack, and 3 weeks on cotton clothing, leather shoes and rubber boots (Cottral GE, 1969). FMDV was reported to survive up to 14 weeks in water FMDV (Cottral GE, 1969). FMDV was reported to survive for 10 weeks on houseflies and 20 weeks in the haematin of ticks (Cottral GE, 1969).

Investigators estimated FMDV would survive 3 months or less in regions with temperatures greater than 20°C and perhaps beyond 6 months in regions with cold temperatures (Bartley LM, Donnelly CA, Anderson RM, 2002). Ireland officials prohibited restocking high risk farms for 5

months after depopulation (O'Malley, R., 2002). Thus, adequate time must be provided before restocking is considered.

Sentinels can be placed on the farm 3 months after decontamination of the premises in warm area. Up to six months after depopulation might be needed in colder climates before the virus has fully degraded. These animals should be closely monitored for signs of disease and seroconversion to FMDV. Sentinels should have contact with all areas of the premises, equipment, and grazing fields. At 60 days after placement, sentinels can be retested for seroconversion. Restocking can be considered if sentinels are seronegative (AUSVETPLAN, 2002).

The easiest way spread FMDV is to bring an infected animal to your herd. FMDV was detected in the soft palate of a recovered animal for 196 days after infection (Cottral GE, 1969). FMDV has been reportedly detected for 2 hours to 58 days in the blood, 12 hours to 246 days in the urine, 13 hours to 5 days in the milk, 9 hours to 11 days in the saliva, 24 hours to 7 days in nasal discharge, 5 hours to 5 days in manure, and 18 hours to 14 days in expired air after animals were inoculated with FMDV (Cottral GE, 1969).

Purchase restock cattle from herds of known health status. Do veterinarian to veterinarian pre conferences. Test animals before purchase, on arrival and before exiting from isolation. Isolate incoming stock for a minimum of 30 days before introduction to the herd. Isolation and testing are important because a FMDV-infected steer remained clinically normal for 8 days; yet, still infected other susceptible steers during this time. The incubation period for disease in the contact steer ranged from 40 to 120 days. The time period from the point of detection of FMDV in healthy cattle exposed to FMDV-infected cattle until lesions appeared was 1 to 7 days in saliva, 1 to 6 days in blood, 1 to 4 days in semen, 1 to 4 days in milk (Cottral GE, 1969). Thus, infected animals may not show overt clinical signs of disease (Graves JH, Mc Vicar JW, Suttmoller P, Trautman R, Wagner GG, 1971).

Vigilance must continue after restocking the premises. A survey of 156 dairies reported an average of 1.6 to 2.6 instances where animals were moved from one livestock facility to another and had direct contact with other animals (Bates TW, Thurmond MC, Carpenter TE, 2001). Dairy calf and heifer units with greater than or equal to 250 animals had an average of 17 direct animal contacts/month as a result of animals arriving to the farm and an average of 22.4 direct animal contacts per month as a result of animals leaving the farm (Bates TW, Thurmond MC, Carpenter TE, 2001). Failure to follow strict isolation and testing procedures after restocking could re-introduce FMDV to your herd.

Artificial Insemination, Germplasm Collection, and Embryo Transfer Protocols

Introduction of genetic material can offer the risk of disease introduction; although, usually this risk is less than when introducing live animals. Still, biosecurity procedures should be in place to screen sources of genetic material and introduce them safely to the farm. Considerations for FMD are below.

Semen

The time period from the point of detection of FMDV in healthy bulls exposed to FMDV-infected cattle until lesions appeared was 1 to 4 days in semen (Cottral GE, 1969).

Infectious FMDV was detected in semen of bulls up to 20 hours after inoculation of the bulls before clinical signs of disease were apparent and up to 10 days after inoculation when clinical signs were disappearing (Cottral GE, Gailiunas P, and Cox BF, 1968).

FMDV remained infectious in semen stored at -50°C for 320 days (Cottral GE, Gailiunas P, and Cox BF, 1968). Today, bull semen is usually stored at 196°C and always below 130°C so survival times might be longer in frozen straws.

Five of sixteen heifers inseminated with FMDV containing semen from FMDV-infected bulls had clinical signs and lesions of FMDV by 16 days after insemination (Cottral GE, Gailiunas P, and Cox BF, 1968).

Thus, we recommend that semen collected from bulls within 21 days before a diagnosis or clinical signs of FMDV were apparent should be destroyed and all semen shipment from that premises should be traced out to determine risk of exposure to other susceptible animals. All semen collected after a diagnosis has been made should be destroyed by incineration.

Germplasm and Embryo Transfer

Germplasm and embryos collected within 3 weeks of the diagnosis of FMD should be incinerated according to Australia's protocols (AUSVETPLAN, 2002). However, washed embryos with intact zona pellucida appear to offer minimal risk of infection (Mebus CA, Singh EL, 1990). The risk would be that the zona pellucida did not remain intact or the samples were contaminated after washing.

Chapter 4: Minimizing Disease Risk Within an Infected or Suspect Zone (Control or Surveillance zone)

Diseases are spread most easily when sick animals contact healthy animals. Thus, an infected or suspect herd (FMD-confirmed site or FMD-investigation site) will be placed under quarantine pending investigation for the presence of FMDV. Animal and product movement on suspect premises (FMD-investigation site) should cease until the herd can be declared free of FMDV. This chapter will discuss testing options to determine if a herd or milk is infected with FMDV, and recommended biosecurity measures for farms in this category such as vaccination, entry and exit procedures; personal protection; movement controls, euthanasia and carcass disposal; milk, manure, feed, and other waste disposal; milk and animal shipment; vector control; cleaning and disinfection; and, replacement options.

Testing

A positive test that shows an animal is infected with FMDV is the basis for herd quarantines and establishment of zone designations. Although, tests are currently available to detect FMDV infected animal, the current tests take at least 24 hours before preliminary results are known. Rapid tests that give immediate results are in the developmental stage and should be available in the near future.

Currently, portable rapid on-farm testing is only available to the government or military. These devices are expensive and sample preparation techniques have not developed to make them a viable option as yet. However, new developments might change this in the near future. If released to the general public, the implications of a false positive on our export market would be extremely detrimental. A more feasible scenario would be release of these test kits to State laboratories, which could then perform regional testing.

A portable real time RT-PCR assay successfully identified all 7 serotypes of FMDV with 100% specificity in two hours or less. The test could also identify FMDV in saliva, tissue or blood samples and in samples collected from animals 24-96 hours before clinical signs (Callahan JD, Brown F, Osorio FA, Sur JH, Kramer E, Long GW, Lubroth J, Ellis SJ, Shoulars KS, Gaffney KL, Rock DL, Nelson WM, 2002).

The Cepheid SmartCycler real time PCR machine accurately and rapidly detected Type O UKG FMD in nasal swab and serum samples from sheep. Weakly positive samples were difficult to detect and TaqMan core reagents were required to optimize the assay. The extraction of RNA and subsequent conversion to cDNA was time consuming and not suitable for field assays. False positive results are one drawback (Hearps A, Zhang Z, Alexandersen S, 2002).

An automated 5'-nuclease probe-based RT-PCR was effective at screening blood and epithelial cell samples for FMDV. Investigators estimated that 64 samples per day could be run (Reid SM, Ferris NP, Hutchings GH, Zhang Z, Belsham GJ, Alexandersen S, 2001).

Care should be taken not to contaminate diagnostic samples with disinfectant (British Veterinary Association Council, 2001).

Vaccination

Vaccination will likely not be effective in the infected (control) zones because animals are probably already exposed or within the distance of a contiguous cull from an exposed herd. See Chapter 3 for more information on vaccination.

Entry and Exit procedures

Entry procedures are designed to restrict exposure and contamination of uncontaminated people, vehicles, equipment, etc, and to prevent mechanical spread of the virus to other premises.

Entry Procedures

Only essential personnel should be allowed on the farm. Vehicles should not be allowed entry to

infected or suspect premises (FMD-confirmed sites or FMD-investigation sites) in this zone. Essential Vehicles should only be allowed on non-infected premises within this zone. Feed should not be brought into dairies with animals showing clinical signs or suspected to be infected. These premises should rely on stored feed instead of delivered feed.

Once a zone is declared infected, tankers already in this zone will be declared dirty and will operate within this zone. This action will minimize the number of clean tankers entering the infected (control) zone.

Ideally, dairies will be tested before the tanker is scheduled and if the bulk tank is found to contain FMDV, then the tanker would not enter the premises.

Preferably, tankers will visit only one uninfected dairy farm within the zone and then go, if possible, directly to a dairy plant within the same milk control zone.

Exit Procedures

People should use the same exit procedures as on quarantined farms until the farm has tested negative for FMDV. All vehicles entering the premises should be considered contaminated. Contaminated vehicles should not exit the farm premises. If vehicles must exit, visible organic material should be removed from the vehicle before the vehicle uses public roads. The vehicle should be thoroughly cleaned and disinfected before entering another premises. Feed should not exit the farm until the farm is declared negative for FMDV.

Milk and tanker exit procedures are described in Chapters 7 and 8.

Personal Protection and Safety

Foot and mouth disease is not considered a public health problem. Personnel should don waterproof disposable outerwear (coveralls, boots, and gloves) in suspect or infected premises (FMD-confirmed sites or FMD-investigation sites) so that they can be decontaminated with ease. Personnel should not transport any FMDV-contaminated fomites, animals, or animal products to FMDV-free areas containing susceptible animals.

Within Premises Movement Controls

Personnel should avoid walking through areas where suspect animals are located. People should work with uncontaminated areas/ healthy animals first and contaminated areas or with suspect animal last. People should have designated disposable clothing and footwear for use with suspect animals. People should shower and don clean clothing and footwear before returning to uncontaminated areas to work with healthy animals.

Movement among contaminated areas of infected farms (FMD-confirmed sites or FMD-investigation sites) will be unrestricted initially. However, as depopulation and decontamination progress, personnel moving within contaminated premises should take care to minimize tracking

the virus to uncontaminated areas within the farm. Areas that have been cleaned and disinfected should be marked off and avoided so that they are not recontaminated.

Euthanasia and carcass disposal

Euthanasia should begin promptly once the herd has been declared FMDV positive (an FMD-confirmed site) or if the herd is contiguous to an infected herd (FMD-confirmed site or FMD-investigation site). Euthanasia and carcass disposal options are outlined in Chapter 3.

Milk, Manure, Feed, Biologics, Drugs and Supply Disposal Options

Milk should be disposed of as in Chapter 3 until the herd is declared FMDV-negative and tankers can be allowed on the premises. Manure, biologics, drugs, and supplies should be disposed of as in Chapter 3 until the herd is declared FMDV-negative.

Milk Shipment

Milk should only be transported from uninfected farms within infected (control) zones as allowed (See Chapter 7). Milk should not be shipped from suspect or infected premises (FMD-confirmed sites or FMD-investigation sites).

Cattle/Animal Shipment

Cattle or other susceptible animals should not be moved out of the infected or suspect zone (Control or surveillance).

Vector Control Options

Vector control options are outlined in Chapter 3.

Cleaning and Disinfection Options

Cleaning and disinfection options are outlined in Chapter 3.

Replacement, Artificial Insemination, Germplasm Collection, and Embryo Transfer Options

Options for replacement of genetic material will vary with the health status of the herd. See Chapter 3 if herd is declared FMDV-positive. See Chapter 6 if herd is declared FMDV-negative.

Chapter 5: Minimizing Disease Risk Within a Surveillance Zone

The health status of animals within the surveillance zone is unknown. These animals are at risk of infection due to their proximity to infected animals. Animals within this zone must be aggressively monitored for signs of disease and tested. This chapter will discuss recommended biosecurity measures for farms in this category such as vaccination, entry and exit procedures; personal protection; movement controls; milk and animal shipment; and manure, feed, and other

waste disposal. Extra care beyond routine farm protocols should be used in this zone until the zone is declared free of FMD.

Vaccination

See Chapter 3 for more information regarding vaccination

Entry Procedures

Milk and tanker entry procedures are described in Chapters 7 and 8.

Exit Procedures

Milk and tanker exit procedures are described in Chapters 7 and 8.

Personal Protection and Safety

See Chapter 4

Within Premises Movement Procedures

See Chapter 4

Milk Shipment Procedures

Milk should only be transported from uninfected farms within surveillance zones (See Chapter 7).

Cattle Shipment

Cattle should not be moved out of the surveillance zone

Manure, Feed, Biologics, Drugs and Supply Disposal, Vector Control, and Artificial Insemination, Germplasm Collection, and Embryo Transfer Procedures

Protocols outlined in Chapter 4 should be used until animals on the premises have been tested and declared FMDV negative.

Chapter 6: Minimizing Disease Risk On Non-Infected Premises within Suspect, Infected, or Surveillance Zones (Control or surveillance zones)

Your herd could be required to depopulate, despite the fact that your herd is not infected if the herd is located in a suspect or infected zone (control or surveillance). However, until the decision is made, biosecurity protocols should be developed and instituted on all farms that are allowed to move milk. This chapter will discuss recommended biosecurity measures for farms in this

category such as quarantine, entry and exit procedures; movement controls; euthanasia; carcass disposal; milk disposal; manure, feed, and other waste disposal; and, replacement options. Extra care beyond routine farm protocols should be used especially if the farm is located in an infected or suspect zone (control or surveillance).

Vaccination

Vaccination of uninfected animals on contiguous premises FMD-investigation site followed by moving those live animals off of the farm to a central culling facility as was done in the Netherlands (de Klerk PF, 2002) is not recommended because vaccinated animals can still become infected and shed FMDV. See Chapter 3 for more information regarding vaccination.

Quarantine Policy

Quarantines will be determined by current regulations. Technically, no quarantine is necessary; however, prudence dictates that people and animal movement should be restricted because animals in a negative herd can rapidly become infected if located in close proximity to infected animals. Moreover, animals can shed FMDV in milk before clinical signs of illness are apparent. Movement of livestock should only occur with government permission using valid health papers written by the veterinarian who examined the herd and animals to be moved.

Entry procedures

People

No visitors. Essential personnel only. Provide coveralls and boots for all non-personnel. Disposable plastic boots and Tyvek coveralls are useful.

Vehicles

Arrive with C & D Tanker. Drivers should look for quarantine signs posted on entry. If quarantine signs are observed the driver should not enter the premises. If the driver enters the premises and is told the farm is possibly infected, then the driver should leave immediately following decontamination.

Drivers should always don disposable boots and disposable waterproof outerwear or a plastic apron that could be sanitized. Ideally, sampling should not be performed by driver. However, if the driver must sample milk, hands should be washed until all visible organic material has been removed and dried completely on arrival and nitrile gloves should be donned during procedures. New boots and outwear are needed for each farm visited during a single run to prevent farm to farm transfer of disease agents.

Equipment should remain at each farm and not be carried by the driver. If above is not possible, drivers should keep individual milk test kits for each farm/plant to be visited such that the same equipment is not shared among farms. After use, any milk testing equipment carried by the driver should be placed in sealed bags and stored outside of the cab area until it can be cleaned and disinfected.

Samples should be bagged by driver and placed in cooler in segregated area of truck

Driver should restrict movements to areas in the immediate vicinity of the bulk tank. Driver should not walk around the farm or contact animals.

Driver should take care not to spill milk or overfill the tanker. Any spillage that occurs during sampling and pumping should be cleaned and disinfected. Any door handles that the driver touches should be disinfected.

Feed

Feed should only originate from non-infected farms within the FMDV-free zone or non-contaminated suppliers within the FMDV-free zone.

Exit Procedures

People

Farm clothing and footwear should remain on the farm.

Vehicles

Milk and tanker exit procedures are described in Chapters 7 and 8.

Feed

Feed can exit the farm however the date and destination should be recorded.

Within Premises Movement Controls

Personnel should always move from the healthiest and youngest animals to the oldest/or sick animals and not return to young/healthy animals without changing outerwear.

Euthanasia, Carcass Disposal, Milk Disposal, Manure and Feed Disposal, Biologics, Drugs and Supply Disposal, Vector Control, and Cleaning and Disinfection Options

These protocols can be developed using information from Chapter 3. They should be part of routine procedures for the farm.

Replacement Options

Even if your herd is FMDV negative, regulations might require that your herd be depopulated if the herd is located adjacent to an infected premises (FMD-confirmed site or FMD-investigation site). In this case, restocking or replacement should only occur after the outbreak is under control and only animals with valid health papers should be moved . Purchase restock cattle from herds

of known health status. Do veterinarian to veterinarian pre conferences. Test animals before purchase, on arrival and before exiting from isolation. Isolate incoming stock off-site for a minimum of 30 days before introduction to the herd. Isolation and testing are important because a FMDV-infected steer remained clinically normal for 8 days; yet, still infected other susceptible steers during this time. The incubation period for disease in the contact steer ranged from 40 to 120 days. The time period from the point of detection of FMDV in healthy cattle exposed to FMDV-infected cattle until lesions appeared was 1 to 7 days in saliva, 1 to 6 days in blood, 1 to 4 days in semen, 1 to 4 days in milk (Cottrel GE, 1969). Thus, infected animals may not show overt clinical signs of disease (Graves JH, Mc Vicar JW, Suttmoller P, Trautman R, Wagner GG, 1971).

Vigilance must continue after restocking the premises. A survey of 156 dairies reported an average of 1.6 to 2.6 instances where animals were moved from one livestock facility to another and had direct contact with other animals (Bates TW, Thurmond MC, Carpenter TE, 2001). Dairy calf and heifer units with greater than or equal to 250 animals had an average of 17 direct animal contacts/month as a result of animals arriving to the farm and an average of 22.4 direct animal contacts per month as a result of animals leaving the farm (Bates TW, Thurmond MC, Carpenter TE, 2001). Failure to follow strict isolation and testing procedures after restocking could introduce FMDV to your herd.

Artificial Insemination, Germplasm Collection, and Embryo Transfer Protocol

Introduction of genetic material can pose a risk of disease introduction. In one study, 436 embryos were collected from 30 superovulated FMDV-viremic cattle that had been experimentally infected. Embryos were washed 10 times according to International Embryo Transfer Society protocols. Infectious FMDV was not found associated with any of the embryos. Recipients of the embryos and resultant calves were FMDV seronegative (Mebus CA, Singh EL, 1990). Thus, embryo transfer does not appear to pose a risk for FMDV transmission as long as the zona pellucidae are intact.

Semen purchases should originate from an uninfected herd within the uninfected zone. Semen should not be transported through infected (control) or surveillance zones enroute to the uninfected farm.

Chapter 7: Milk Movement

A practical approach is needed to address the need to move large volumes of milk daily off non-infected farms during an FMD outbreak. Safe, efficient milk movement is required for the following reasons:

Large volumes of fluid raw milk move daily in large bulk milk tankers to many different interstate locations for pasteurization and/or further processing, depending on varying market utilization needs at any given time for specific processed products such as fluid milk, cheese and/or dried milk powder.

If milk is not routinely picked-up from dairy production facilities at risk of infection or expected to be infected, such milk must be dumped when excess storage capacity is exceeded, frequently within 24 hours.

If the milk must be destroyed on noninfected dairy production facilities, regardless of location, an immediate indemnification problem must be addressed, not to mention treatment, disposal and potential environmental pollution control issues.

Pasteurization, cleaning and disinfection control capabilities exist at processing facilities, where added biosecurity controls can be added to prevent spread of FMDV from milk tankers and drivers.

Once fluid raw milk is pasteurized, the risk of spread of FMDV could be greatly reduced, even if such processed products were to be accidentally fed directly to susceptible livestock, as demonstrated by the recent risk assessment conducted by CEAH/APHIS.

Appropriate implementation of biosecurity controls at the dairy production facility, during tanker transit, and at the milk pasteurization or cheese processing plant minimizes the risk of spread of FMDV.

If the normal procurement and distribution channels for marketing and processing of fluid raw milk is disrupted beyond 72 hours, significant milk shortages could occur in supermarkets, assuming the consumer can be convinced FMD is not a public health concern.

Milk drivers, producers, veterinarians and milk processors can be prepared in advance to implement a given level of biosecurity protection required in a designated FMD milk control zone if an FMD outbreak occurred (See Chapter 3).

This chapter describes a milk movement control system to minimize disruption of normal milk procurement routes to pasteurization and cheese processing plants. The designations for milk control zones will not necessarily correspond to the designations for the outbreak control zones. The three different milk control zones are described below:

FMD Outbreak Milk Control Zone

The premise where the outbreak is first detected, immediate surrounding, adjacent or contact premises, and any and all other premises determined positive within an FMD Area Control Zone. The use of validated PCR portable milk assays will be available in the future to assist with monitoring on-farm bulk tanks prior to pick-up within this control zone and for trace back if FMDV is detected at milk receiving plants. An effort should be made to limit the number of dairy production facilities within this area that are determined not to be infected in order to minimize milk disposal and immediate indemnity issues resulting from lost opportunity to market milk. No milk can be picked-up from any infected dairy production facility within this zone. Milk from non-infected dairy production facilities may be picked-up from within this zone, provided the milk moves directly to a milk pasteurization and/or cheese processing facility, with

no commingling of milk permitted between dairy production facilities. If a milk tanker truck must cross into a FMD Milk Area Control Zone, it must first be stopped and completely washed and disinfected. It must also be rewashed and disinfected at the farm entry point after having been previously washed and disinfected at the plant.

FMD Milk Area Control Zone

The boundaries of this zone will be established by State or Area Co-Incident Commanders on a county-by-county or state-by-state basis to incorporate as large a concentration of dairy herds as possible aligned with as many processing plants as possible with strict biosecurity controls governing milk movement. An effort should be made to broaden this area to the extent necessary, regardless of county or state boundaries, so as to be able to maintain normal milk procurement alignments between dairy production facilities and milk and cheese processing plants.

FMD Milk Buffer Control Zone

The geographical area situated beyond the extremities of the FMD Milk Area Control Zone where normal milk movement is permitted to occur with adjustments made to biosecurity controls as determined necessary by APHIS/VS.

Chapter 8: Milk Tanker and Vehicle Biosecurity for Milk and Supply Movement

This chapter discusses biosecurity recommendations for tankers used in milk movement. Some recommended technology is not currently available. Until real-time diagnostic methods are widely available, currently available testing procedures and extreme vigilance in monitoring for sick animals must be used.

Ideally, the bulk tank at the dairy farm will be tested for FMDV prior to loading using a rapid real time PCR test. Milk from any bulk tank that tests positive will not leave the farm. Similarly, and independent of milk testing, milk will not be transported from any dairy farm with animals showing characteristic or suspicious signs of FMDV or that test positive for FMDV using conventional methods or by real time PCR. Milking of cows should stop once a farm has been diagnosed as FMDV positive. Prompt and humane euthanasia of all susceptible animals on the premises should begin at such time. Milk in the bulk tanks of these farms should be disposed of using approved milk disposal procedures.

Use of same tanker to pick up milk each day at the same farm is preferred but might not always be practical. Use of multiple tankers going to different farms each day increases the risk of disease transmission.

As the technology becomes available, all tankers will be equipped with filters to prevent virus from being released into the environment from milk being transported in the tank. Filters are needed on all tankers because transported milk could be of unknown infection status.

Milk from non-infected dairy production facilities may be picked-up from within the FMD Outbreak Control Zone, provided the milk moves directly to a milk pasteurization and/or cheese processing facility, with no commingling of milk permitted between dairy production facilities. At entry to the dairy farm, the vehicle should be completely power washed and disinfected at the hard surface entrance to the milk production facility. This process should be repeated after the tanker has been loaded with milk and has returned to the hard surface area. Spraying the tankers tires with disinfectant during the time on the farm premises while off of the hard surface area would be impractical due to the sheer volume of disinfectant needed for continual spraying. Targeted tire spraying with disinfectant immediately prior to farm entry and after farm exit would be feasible and recommended.

If a milk tanker truck must cross into a FMD Milk Area Control Zone, it must first be stopped and completely washed and disinfected. It must also be rewashed and disinfected at the farm entry point after having been previously washed and disinfected at the plant.

At all processing and milk receiving stations within both the FMD Outbreak and FMD Control Area zones, all plants would be required to construct temporary wash bays to be located directly ahead of the normal entrance to the raw milk receiving bay(s), so as to enable all milk tanker trucks to be completely washed prior to entering the receiving bay. Raw milk within the arriving tanker could not be sampled prior to this time. All receiving bays would be required to be separated with splash resistant drop pads or temporary shields. All milk tanker trucks would be required to be washed and disinfected prior to exiting the receiving bay and exit by a different route and gate from the gate and entrance to the temporary wash station. If a milk tanker truck picks up milk from a non infected dairy production facility in a FMD Outbreak Control Zone and must pass through a FMD Milk Control Area to reach a milk receiving or processing plant, then prior to entering the FMD Milk Control Area, the milk tanker truck would be required to be completely washed and disinfected before proceeding. This might best be accomplished at any enclosed washing facility approved by the State Veterinarian or Co-Incident Commanders. Less stringent requirements may be applied in the outside FMD Milk Buffer Control Zone.

Drivers

Drivers must be protected against all liability if they follow protocols or truckers will refuse to enter zones

Drivers must be compensated for extra washes including travel time to an approved facility.

Drivers should be compensated for extra trips if they are only allowed to pick up milk at one farm at a time.

After tanker is loaded, the driver should remove and bag disposable boots, outerwear and gloves in same order and place them in segregated area of tanker outside of the cab.

Driver should drive directly to dairy plant if possible.

Before next visit and after tanker is cleaned, all visible organic material should be removed from drivers' footwear and then footwear should be disinfected by following the label directions of an appropriate disinfectant (Amass et al, 2001).

Driver washes (minimum 15 seconds) and completely dries hands before going to next farm. Showering is required if Driver was on suspect or infected farm(FMD-confirmed site or FMD-investigation site).

Drivers' street clothes should be laundered in hot water using detergent and then machine dried. Clothing should remain dry for 20 hours before being reused (Sidwell et al, 1971).

Chapter 9: Milk Plant Biosecurity

Milk plant biosecurity is needed because FMDV-Infected cows can shed virus in the milk before a diagnosis of FMD can be made. In such instances, FMDV-positive milk will likely be transported to dairy plants unknowingly.

Milk of unknown status due to lack of on farm testing should be transported to dairy plants within the quarantine zone. Dairy plants producing mozzarella cheese are preferred.

Other supplies carried by contaminated vehicles can also pose a risk. All vehicles, not just milk tankers, should follow appropriate biosecurity protocols (See Chapter 8).

The milk plant itself should have security measures to prevent intentional tampering with product, supplies, or equipment. Record-keeping to allow traceforward and traceback of all people, vehicles, products, etc should be in place.

Each milk plant is unique in regard to facilities and biosecurity protocols. This chapter supplies guidelines for milk plant biosecurity. Producers are encouraged to contact the milk plant(s) that they use to get specific biosecurity procedures used by that plant. Milk plant managers can refer to the International Dairy Foods Association guidance document entitled “Biosecurity in the Dairy Plant” for further information.

Milk Tanker Receiving

See Chapter 8 for specifics regarding vehicle biosecurity. Receiving can be a point of vulnerability. Tankers should be secured as soon as possible upon entry. Tankers should not be left unlocked or unattended.

Tankers should have a designated road path such that tankers entering and exiting dairy plant premises do not share the same road. Dirty entering tankers should follow one path while cleaned and disinfected tankers leaving the dairy plant should use a separate path.

Milk should be tested for the presence of FMDV using a rapid test. Milk can be off loaded from tanker if milk is FMDV negative. Attach a pressurized air source to inlet of filter housing on top

of tanker. Prepare hoses for off loading. Apply air pressure to the inside to the tanker, thereby pushing milk out of the tanker. Used filters should be disposed of accordingly. Replace filter and perform integrity test (Kalman D, Pall Food and Beverage, 2001)

If milk is FMDV positive follow offloading procedures and dispose of milk at milk disposal site. Steam or autoclave failed filter assembly. Discard filter. Re-use sterilized filter housing. Replace filter and perform integrity test (Kalman D, Pall Food and Beverage, 2001).

Dairy plants in surveillance zoned choosing to accept milk from suspect areas (FMD-investigation site) should schedule those tankers for arrival at the end of the day.

Test milk sample collected at farm using rapid test for FMDV as technology becomes available.

Driver/Dairy Plant Personnel Biosecurity

Drivers should be registered with the plant and carry identification which can be checked on arrival.

Personnel should wear waterproof disposable outerwear and plastic disposable boots or rubber boots. Any person who has handled infected milk must shower and change clothing and footwear before entering a clean area. Showering is necessary because aerosolized particles that contain FMDV can sometimes penetrate protective clothing. Moreover, people will inevitably touch their face, hair, etc with contaminated gloves. Personnel in the dairy plant should be restricted to movement within their area to avoid cross-contamination of dairy plant areas.

Sample Collection

Sample collection areas and equipment should be cleaned and disinfected in between each tanker.

Weigh In

Scales should be cleaned and disinfected between each tanker. If weather does not permit disinfection with liquid agents, powder desiccants such as Stalosan F could be used; although Stalosan's efficacy under these conditions has not been tested.

Unloading Milk

Contaminated Milk

Clean off any visible organic material from the exterior of the tanker. Add disinfectant to tanker if there is any room and wait one hour and proceed to disposal site. Clean and disinfect tanker after milk disposal.

Clean Milk

Unload as usual. At the dairy plant clean and disinfect areas where milk is unloaded, any spilled milk, and any equipment used to handle milk after each tanker. (AUSVETPLAN, 2002).

Milk Tanker Washing and Cleaning

- Truck washing procedures are referenced (Ford, 1995; Poumian, 1995; Böhm, 1998)
- Cleaning and disinfection cannot be achieved under open air conditions in cold weather. A permanent or temporary enclosed facility with temperatures greater than 10°C and a contained drainage area is needed.
- If tanker has a CIP (Clean in place system), flush CIP with hot water and mount ball rotator or wand washing system.
- Pre-Rinse with 38-46F water.
- Circulate 1/100 dilution of sodium metasilicate, pentahydrate solution (available in 55 gallon drums), or other EPA approved disinfectant validated by peer-reviewed research, at 49-77F for 15 minutes. FMDV should be inactivated at this point.
- Make new solution for every tanker from infected (control) or surveillance zone.
- Flush tanker with three, 49-77°F flushes of water with no soap.
- Flush with cool water for final rinse to prevent foaming.
- Disinfect inside of tanker using an appropriate disinfectant according to label directions (may not be needed for FMDV, but required by industry).
- Remove organic material from small parts and equipment using hot water. Disinfect small parts and equipment using an appropriate disinfectant according to label directions before replacing them on tanker. Disinfectant should be approved by FDA.
- Organic material should be removed from inside cab and interior of cab C&D as needed. Dispose of all trash. Clean all compartments.
- Remove all visible organic material from outside of tanker using hot water (49-77C). Take care to avoid splashing adjacent tankers during the washing process. Curtain can be installed in bays to prevent splashing.
- Begin at top and work down. Include cab, undercarriage, wheel wells, and tires.
- Disinfect all outer surfaces of tanker.
- At least a 10 minute disinfectant contact time is recommended but use appropriate disinfectant as per label directions.

- Rinsing may be necessary if product is corrosive.
- The tanker filter will also be tested for integrity. If the filter fails the integrity test it must be replaced before milk can be hauled.
- Rinse water from tankers washed after hauling FMDV-positive milk should be considered FMDV positive and should be handled according to EPA requirements.

Milk Tanker Release

An inspector should be designated to approve the release of each tanker. The air filter should be checked for integrity and replaced if found to be defective. Supplies such as disinfectant, disposable boots and disposable outerwear should be replenished.

Milk Tanker Released and then Found to Be Contaminated

Notify farm or dairy plant to which tanker is enroute. Contact driver by radio and arrange for tanker to be rerouted to truck wash site or to milk disposal site if tanker has been refilled. Notify farms that tanker visited. Isolate and decontaminate milk in infected silo (AUSVETPLAN, 1996).

Milk Processing

Milk (unusable is not a good substitute for contaminated because contaminated does not mean unusable) contaminated with FMDV does not pose a human health concern. However, contaminated milk can be a source of infection for livestock and should not be fed to susceptible species. Contaminated milk can also spread the disease so it should not be exported to FMDV-free areas. Standard milk and cheese pasteurization and/or processing procedures are not sufficient to eliminate FMD from dairy products, but in some cases may reduce the number of viral particles to less than an infectious dose (Risk Assessment of foot-and-mouth disease virus spread, Aaron Scott, draft).

Raw Storage

Raw milk is potentially contaminated and care should be taken to minimize spillage or aerosolization. Spilled milk should be cleaned and the contaminated areas disinfected immediately. All equipment used to handle raw milk should be disinfected at frequent intervals.

Pasteurization

Most studies regarding survival of FMDV in product were performed using experimentally infected cattle and small quantities of milk; therefore, decontamination processes may not work in practice. OIE standards should be followed until research provides us with definitive answers.

Milk and cream for human consumption can be heated to at least 132°C for at least 1 second (UHT). Milk with a pH less than 7.0 can be decontaminated using simple high temperature - short time pasteurization (HTST). Milk with a pH of 7.0 or over, requires double HTST (O.I.E. International Animal Health Code, 2002).

Milk for animal consumption can be heated to 72°C for at least 15 seconds (double HTST), HTST plus maintenance at pH<6 for at least 1 hour or additional heating to at least 72°C combined with desiccation, or UHT followed by maintenance at pH<6 for at least 1 hour or additional heating to at least 72°C combined with desiccation (O.I.E. International Animal Health Code, 2002).

Milk

FMDV survived in experimentally contaminated milk for 9 to 12 days, buttermilk for 14 days, and dried milk for 2 years (Cottrel GE, 1969).

Heating milk to temperatures of 138°C was not sufficient to inactivate virus (Cunliffe et al, 1979).

Whole milk was collected from three cows 1 day after experimental inoculation with FMDV. Infectious FMDV was detected in milk heated to 72°C for 15-17 seconds, 80°C for 15-17 seconds, and pasteurized milk after evaporation at 65°C to half the original volume (Hyde JL, Blackwell JH, Callis JJ, 1975).

Investigators in pasteurization studies using milk from experimentally infected cattle reported detection of infectious FMDV in whole milk and skim milk heated to 72°C for 15 seconds (Blackwell JH, McKercher PD, Kosikowski FV, Carmichael LE, and Gorewit RC, 1982).

Investigators in studies using milk from three experimentally infected cattle reported detection of infectious FMDV in whole milk heated to 72°C for 5 minutes, whole milk heated to 72°C for 3 minutes and evaporated to 50% of original volume by heating at 65°C for up to one hour, and skim milk heated to 72°C for 2 minutes (Blackwell JH, Hyde JL, 1976).

Infectious FMDV was not detected in skim milk heated to 72°C for 30 seconds and evaporated to 50% of original volume by heating at 65°C for up to one hour (Blackwell JH, Hyde JL, 1976).

FMDV was inactivated in milk obtained from FMDV-inoculated cows after heating at 100°C for over 20 minutes or 148°C for 2.5 seconds (Walker JS, de Leeuw PW, Callis JJ, van Bakkum JG, 1984).

FMDV in two samples of milk collected from three cows experimentally inoculated with FMDV was inactivated when heated to 148°C for 2-3 seconds. Treating milk at 148°C for at least 3 seconds using portable UHT units is an option for eliminating the infectivity of FMDV in milk. Milk treated by UHT can be unsuitable for cheese production but can be used to produce dried casein (Cunliffe et al, 1979).

Butter

Infectious FMDV was recovered from butter and butter oil prepared from milk from three cattle experimentally inoculated with FMDV. Products were made from cream immediately after milk collection and from milk stored at 4°C for 18 hours after collection. Infectious FMDV was isolated after storage of butter and butter oil for 45 days after production at 4°C (Blackwell, 1978).

Butter fat was assumed to confer protection to the virus (Blackwell JH, Hyde JL, 1976).

FMDV survived in experimentally contaminated plain salted butter for up to 45 days (Cottral GE, 1969).

Cream

FMDV was also isolated from cream samples heated to 93°C for 16 seconds. Thus, processing under these conditions did not destroy FMDV (Blackwell, 1978).

Investigators in pasteurization studies using milk from experimentally infected cattle reported detection of infectious FMDV in cream heated to 93°C for 15 seconds (Blackwell JH, McKercher PD, Kosikowski FV, Carmichael LE, and Gorewit RC, 1982).

Investigators in studies using milk from three experimentally infected cattle reported detection of infectious FMDV in cream heated to 93°C for 15 seconds (Blackwell JH, Hyde JL, 1976).

FMDV survived in experimentally contaminated cream for 10 days (Cottral GE, 1969).

Cheese

Milk collected from cows experimentally inoculated with FMDV was used to prepare Cheddar or Camembert cheese. FMDV was detected in the sweet whey byproduct of the cheeses which was processed at temperatures of 67°C for 1 minute or 72°C for 0.25 minutes. Infectious FMDV was not detected in whey constituents (α -lactalbumin, β -lactoglobulin, lactose) produced from FMDV positive milk. Fat and protein seemed to have a protective effect for FMDV in milk during processing (Blackwell, 1978a).

Infectious FMDV was detected in Cheddar and Camembert cheese, but not Mozzarella cheese made from milk from six experimentally infected cows. The acidic environment (pH 5.1) coupled with temperatures approaching 85°C was thought to have inactivated FMDV in Mozzarella cheese; whereas, despite the acidity, temperatures did not exceed 37.8°C in the manufacture of the Cheddar and Camembert cheese (Blackwell JH, 1976).

FMDV survived in experimentally contaminated Camembert cheese for 5 minutes, Edam cheese for 22 hours, Linberger curds for 14.5 hours, Quadrat & Tilsiter curds for 6 hours and Cheese whey for 23 hours (Cottral GE, 1969).

AUSVETPLAN allows for the manufacture of cheddar cheese from milk heated to 72°C for 15 seconds, provided that the cheese is stored for at least 90 days at a pH of less than 5.5 (AUSVETPLAN, 2002). It seems though that this cheese would remain infectious.

Casein

Casein produced by precipitation at pH 4.6 from raw skim milk and skim milk pasteurized at 72°C for 15 seconds from FMDV-infected cows contained infectious FMDV (Cunliffe and Blackwell, 1977).

Infectious FMDV was found in dried casein produced by pasteurization of milk from FMDV-infected cows at 72°C for 15 seconds, acid precipitation, washing of the casein, drying of the casein at temperatures of 65-68°C for 10 minutes, and conversion to sodium caseinate. (Cunliffe, Blackwell, and Walker, 1978).

AUSVETPLAN allows milk to be used for making acid casein that is precipitated at a pH of less than 5.2 (AUSVETPLAN, 2002). Again, it appears that this casein would be infectious.

Product Isolation and Testing

Product for human consumption can be shipped to areas within the infected (control) and surveillance zones but should not be exported to FMDV-free zones. Products for animal consumption should be isolated and tested. Products should only be released for animal consumption if milk originated from a FMDV-free zone and was processed in an FMDV-free dairy plant.

Dairy Plant Waste

Liquid waste can be acidified or alkalinized. Dilution of waste with water might reduce infectivity.

0.2% citric acid should be used to decontaminate large volumes of dairy plant effluent. Effluent should be mixed and held for at least 1 hour at pH <4.5 before disposal (AUSVETPLAN, 1996).

Rennet, casein, whey or other wastes must not be sprayed over pastures, discharged into drains, or fed to animals, unless treated with disinfectant, as for milk (AUSVETPLAN, 1996). I would not feed them to animals at all.

Casein and cheese plant waste should be acidified and milk powder and butter plant waste should be alkalinized (AUSVETPLAN, 1996).

Condenser water can be contaminated with FMDV. Water from evaporators producing high-heat powder (WPNI less than 1.5mg/gm) should be safe provided that the Vacreator operates at or above 87°C out of the preheat section, preheat tubes are operational and well-maintained,

throughput does not exceed 11,400 liters per hour (AUSVETPLAN, 1996). I still need help with these numbers from the group. Does this apply to our plants?

Product Distribution

Product distribution vehicles should follow the same rules as dairy tankers

Chapter 10: Current Producer Recovery and Compensation Policy

Compensation should be for fair market value. In Taiwan, when producers were offered compensation in excess of the market value of the animals for infected animals, producers intentionally infected their herds because an infected animal was worth more than a healthy animal. Therefore, overcompensation is not recommended, but producers should be compensated fairly for the worth of the animals and milk (See Chapter Two: Federal Responsibilities).

Chapter 11: Veterinary Responsibilities

Prevention, recommendation of herd health and biosecurity plans, diagnosis, monitoring, assisting with health checks associated with isolation and restocking, and being a friend to producers and helping them get through the rough times are all veterinary responsibilities.

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Acronyms

FMD- foot-and-mouth disease

FMDV- foot-and-mouth disease virus

Glossary

Appendices